

REMARKS

Claims 11-20 through are pending in this application. In response to the Office Action dated December 10, 2004, the specification has been amended to correct an obvious typographical error at page 7. The recited graded titanium nitride layer has been corrected to read as graded tantalum nitride layer (two occurrences). Care has been exercised to avoid the introduction of new matter. Adequate descriptive support for the present Amendment should be apparent throughout the originally filed claims and disclosure as, for example, the depicted embodiments and related discussion thereof in the written description of the specification. Applicant submits that the present Amendment does not generate any new matter issue. Claims 11-20 have not been amended.

Independent claim 11 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Cooney, III et al. (U.S. Pat. No. 6,461,675, hereinafter “Cooney”) in view of Li et al. (U.S. Pat. No. 6,461,675, hereinafter “Li”) and Chiang et al. (U.S. Pat. App. Pub. No. 2001/0018137, hereinafter “Chiang”). Applicants respectfully traverse.

Independent claim 11 describes a semiconductor device comprising an opening in a dielectric layer and a composite barrier layer formed on a surface of the dielectric layer lining the opening. The surface of the dielectric layer comprises a nitrogen (N₂)-enriched surface region. The composite barrier layer comprises an initial graded layer of tantalum nitride containing N₂ in an amount decreasing in the direction away from the N₂-enriched surface region. A layer of alpha-tantalum (α -Ta) on the graded tantalum nitride layer.

As admitted by the Examiner, the primary reference, Cooney, fails to disclose or remotely suggest a semiconductor device comprising (1) a surface of a dielectric layer having a

nitrogen (N₂)-enriched surface region or (2) a composite barrier layer comprising an initial graded layer of tantalum nitride containing N₂ in an amount decreasing in the direction away from the N₂-enriched surface region.

The Examiner asserted that Li teaches a dielectric layer 14b comprising a nitrogen rich surface region and concluded that it would have been obvious to one having ordinary skill in the art to incorporate the teaching of Li into Cooney's device in order to "reduce the dielectric constant of the dielectric layer". Applicants traverse the rejection.

It is well established that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge readily available to one of ordinary skill in the art. *In re Kotzab*, 217 F.3d 1365, 1370 55 USPQ2d 1313, 1317 (Fed. Cir. 2000); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). The determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention." ATD Corp. v. Lydall, Inc., 159 F.3d 534, 546, 48 USPQ2d 1321, 1329 (Fed. Cir. 1998). There must be a teaching or suggestion within the prior art, within the nature of the problem to be solved, or within the general knowledge of a person of ordinary skill in the field of the invention, to look to particular sources, to select particular elements, and to combine them as combined by the inventor. *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 665, 57 USPQ2d 1161, 1167 (Fed. Cir. 2000); *ATD Corp*, 159 F.3d at 546, 48 USPQ2d at 1329. Applicants submit that this burden has not been discharged.

Applicants submit that the Examiner has not established a *prima facie* basis to deny patentability to the claimed invention under 35 U.S.C. § 103 for lack of the requisite factual basis

and lack of the requisite realistic motivation. The secondary reference to Li, discloses an upper lying nitrogen rich dielectric later 14b' and a lower lying nitrogen poor dielectric layer 14a" as shown in Figure 3. Li fails to teach or remotely suggest a composite barrier layer formed on the surface of the dielectric layer. Rather, Li's objective is to enhance adhesion between the nitrogen rich dielectric later 14b' and any additional overlying layer. See Li at col. 4, lines 45-58. Thus, Li is not even concerned with the problems associated with interconnects and barrier layer adhesion to dielectric layers. The Examiner's mere identification of claim features in disparate references does not establish the requisite realistic motivation to support the ultimate legal conclusion of obviousness under 35 U.S.C. § 103. *Grain Processing Corp. v. American-Maize Products Co.*, 840 F.2d 902, 5 USPQ2d 1788 (Fed. Cir. 1988). Moreover, the Examiner's generalization to combine the references to "reduce the dielectric constant of the dielectric layer" does not establish the requisite motivation to modify a specific reference in a specific manner to arrive at a specifically claimed invention. Applicants submit that the only motivation for a surface of a dielectric layer having a nitrogen (N_2)-enriched surface region is Applicants' own disclosure. Applicants' disclosure, however, is forbidden territory for the Examiner to obtain the requisite motivation for combining the applied prior art. *Panduit Corp. v. Dennison Mfg. Co.*, 774 F.2d 1082, 227 U.S.P.Q. 337 (Fed. Cir. 1985). Accordingly the rejection of independent claim 11 under 35 U.S.C. § 103(a) is not legally viable and should be withdrawn for at least this reason.

Moreover, as admitted by the Examiner, the proposed combination of Cooney and Li fails to disclose or remotely suggest a semiconductor device comprising a composite barrier layer comprising an initial graded layer of tantalum nitride containing N_2 in an amount decreasing in the direction away from the N_2 -enriched surface region. The Examiner stated that Chiang teaches decreasing nitrogen in the tantalum nitride layer and concluded it would have been obvious to

one having ordinary skill in the art to incorporate the teachings of Chiang into the device of Cooney/Li in order to "enhance the property of the barrier layer". Applicants traverse.

The Examiner has again failed to provide facts and explain why one having ordinary skill in the art would have been realistically motivated to modify the particular semiconductor device disclosed by Cooney/Li with Chiang to arrive at the present claimed invention. *In re Rouffet*, 149 F.3d 1350, 47 USPQ2d 1453 (Fed. Cir. 1998). In order to establish the requisite motivation, the Examiner must make "clear and particular" factual findings as to a specific understanding or specific technological principle which would have realistically impelled one having ordinary skill in the art to modify a particular prior art reference to arrive at the claimed invention based upon facts, not generalizations, such as the Examiner's "enhancing the property of the barrier layer" assertion. Accordingly, for the reasons outlined above, the rejection of independent claim 11 under 35 U.S.C. § 103(a) is not legally viable and should be withdrawn.

Applicants further submit that the Examiner's analysis ignores whether the present claimed invention as a whole is obvious over the applied prior art. In analyzing whether the claimed invention as a whole, the Examiner cannot consider the invention as only a collection of claimed parts (or features). Rather, an "invention as a whole" analysis also requires the Examiner to consider the claimed interactions between the claimed parts (or features). Indeed, the present invention (as described in the present application at page 5, lines 19-33) addresses and solves the problems of the prior art by forming a N₂-enriched surface region of the dielectric layer prior to a tantalum nitride layer being formed over the N₂-enriched surface region of the dielectric layer. The tantalum nitride layer is formed having a graded N₂ concentration such that the amount of N₂ decreases in a direction away from the N₂-enriched surface region. Continued Ta deposition results in the formation of a thin α -Ta layer on the graded tantalum nitride layer. The resulting composite barrier layer, comprising the graded tantalum nitride layer in contact with dielectric

material and a layer of α -Ta in contact with the Cu metallization, solves adhesion issues generated by the poor adhesion of β -Ta to dielectric material and the poor adhesion of tantalum nitride to Cu metallization. Deposition of Ta on a layer of tantalum nitride advantageously results in α -Ta, since the graded tantalum nitride layer serves as a template for the growth of α -Ta, a low resistivity form of Ta, typically exhibiting a resistivity of about 40 to about 50 $\mu\text{ohm-cm}$ vis-à-vis about 200 to about 250 $\mu\text{ohm-cm}$ for β -Ta.

Dependent claims 12-17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Cooney and Li in view of Chiang and further in view of Venkatesan (U.S. Pat. No. 6,326,301, hereinafter “Venkatesan”). Applicants respectfully traverse.

Dependent claim 18 was rejected 35 U.S.C. § 103(a) as being unpatentable over Cooney and Li in view of Chiang and further in view of Brennan et al. (U.S. Pat. No. 6,548,400, hereinafter “Brennan”). Applicants respectfully traverse.

Dependent claim 19 was rejected 35 U.S.C. § 103(a) as being unpatentable over Cooney, Li and Chiang in view of Grill et al. (U.S. Pat. No. 6,265,779, hereinafter “Grill”). Applicants respectfully traverse.

Dependent claim 20 was rejected 35 U.S.C. § 103(a) as being unpatentable over Cooney, Li and Chiang in view of Brennan and in further view of Venkatesan. Applicants respectfully traverse.

Applicants incorporate herein the arguments previously advanced in traversal of the rejection of independent claim 11 under 35 U.S.C. § 103(a) predicated upon Cooney, Li and Chiang. The remaining references to do not cure the argued deficiencies of Cooney, Li and Chiang. Ergo, even if the applied references are combined as suggested by the Examiner, and Applicants do not agree that the requisite realistic motivation has been established, the claimed invention will not result. *Uniroyal, Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 USPQ2d 1434

(Fed. Cir. 1988). Accordingly, the remaining rejections of claims 12-20 under 35 U.S.C. § 103(a) are not legally viable and should be withdrawn.

It is believed that pending claims 11-20 are now in condition for allowance. Applicants therefore respectfully request an early and favorable reconsideration and allowance of this application. If there are any outstanding issues which might be resolved by an interview or an Examiner's amendment, the Examiner is invited to call Applicants' representative at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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